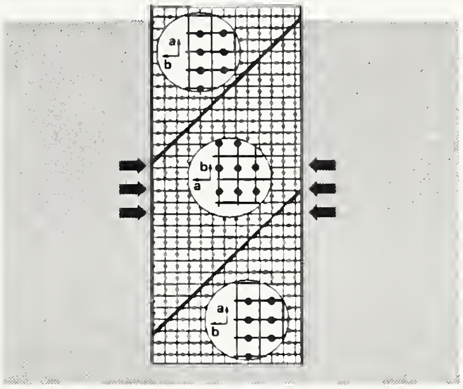
IMSE

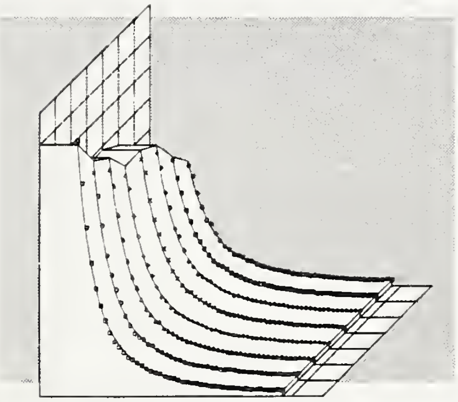
Institute for Materials Science and Engineering

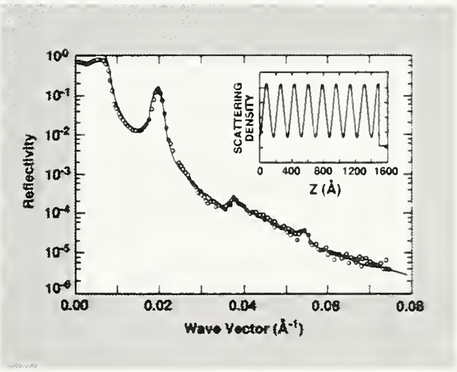
ANNUAL REPORT

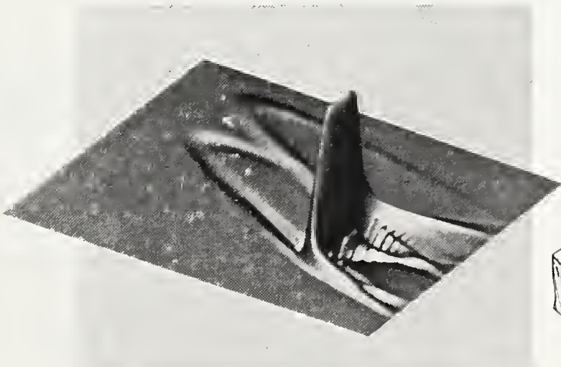
1989

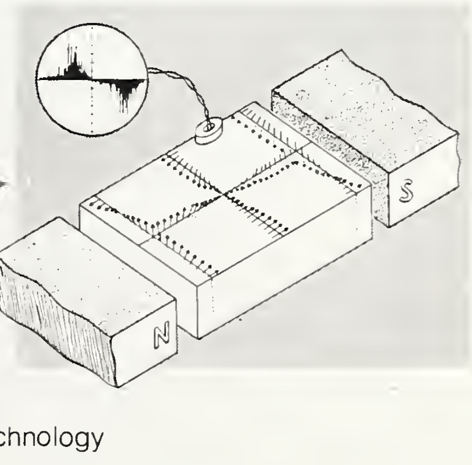
NAS-NRC
Assessment Panel
February 1–2, 1990











NISTIR 89-4146

U.S. Department of Commerce
National Institute of Standards and Technology

Annual report covers for the operating divisions of the Institute for Materials Science and Engineering and its Office of Nondestructive Evaluation. These annual reports describe in detail the technical activities of each of the Institute's major units and are available on request.

IMSE

Institute for Materials Science and Engineering

ANNUAL REPORT

1989

L.H. Schwartz, Director
H.L. Rook, Deputy Director

On October 3, 1989, the Institute for Materials Science and Engineering was renamed Materials Science and Engineering Laboratory.

January 1990

U.S. Department of Commerce
National Institute of Standards and Technology

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FINAL AGENDA

BOARD OF ASSESSMENT PANEL OF NIST PROGRAMS
FOR THE MATERIALS SCIENCE AND ENGINEERING LABORATORY (MSEL)

Wednesday, January 31, 1990

8:00 p.m. Get Acquainted Meeting in the Montgomery Room at the Compri Hotel (L. H. Schwartz, H. L. Rook, D. B. Butrymowicz, S. J. Schneider, J. G. Early, and Panel Members), and Charge to Panel

Thursday, February 1, 1990

8:00 a.m. Panel meets Compri van in front of Compri Hotel for ride to Administration Building, NIST

Lecture Room A

8:15	Coffee and Doughnuts	Lecture Room A
8:30	Opening Remarks	H. Sorrows
8:40	Opening Remarks	F. Padovani
8:50	MSEL Overview	L. Schwartz
9:10	Overview of the Office of Nondestructive Evaluation	H. T. Yolken
9:30	Discussion of the Office of Nondestructive Evaluation	
9:40	Overview of Metallurgy Division Programs	E. N. Pugh
10:00	Discussion of Metallurgy Division Programs	
10:10	Break	
10:30	Overview of Ceramics Division Programs	S. Hsu
10:50	Discussion of Ceramics Division Programs	
11:00	Overview of Materials Reliability Division Programs	H. McHenry
11:20	Discussion of Materials Reliability Division Programs	

11:30 Travel to Senior Lunch Club

11:45 Lunch - Dining Room C
Panel Members, L. Schwartz, H. Rook, D. Butrymowicz, S. Schneider, and J. Early

Lecture Room B

12:45 pm Poster Presentations - Industrial Interactions
(This year's poster session displays the broad range of research in our materials program and the extent of cooperation between NIST researchers and their counterparts in American industry.)

o Neutron Reflectivity Determination of Diblock Copolymer Properties - S. K. Satija and C. F. Majkrzak
with Exxon and IBM

o Industrial Applications of Small-Angle Neutron Scattering - C. J. Glinka, et al.
with Exxon, AT&T Bell Labs, and IBM

o Nondestructive Evaluation Eddy Current Sensors for Aluminum Processing - A. Kahn and M. Mester
with Aluminum Association

o Ceramic Powder Characterization U.S. Working Group - S. Malghan
member U.S. Working Group for Powder Characterization/ International Energy Agency

o Processing of Ceramic Superconductors - S. Freiman
with Electric Power Research Institute

o Influence of Macromonomers on Polymer Phase Separation - B. Bauer
with duPont

o State of the Art Survey of Composite Cure Monitoring Sensors
D. L. Hunston and W. G. McDonough
with National Center for Manufacturing Sciences

o Structure of PVA Gels - W. L. Wu
with Interez Corporation

o HIP - DARPA Program on Intermetallics - R. Schaeffer
with BDM Corporation, Pratt & Whitney, and Crucible

- Fiber Coatings for Metal Matrix Composites - D. Lashmore with American Cyanamid and Avco/Textron

- Metallurgical Data for Direct Forging of Microalloyed Bar Steels - I-Yen Cheng and H. McHenry with Chrysler, Eaton Corporation, and Chaparral Steel

1:45	Overview of Polymers Division Programs	L. Smith
2:05	Discussion of Polymers Division Programs	
2:15	Overview of Reactor Radiation Division Programs	M. Rowe
2:35	Discussion of Reactor Radiation Division Programs	
2:45	Summary and General Discussion	L. Schwartz
3:00	Coffee and soda break	
3:15	Travel to Cold Neutron Research Facility	
3:30	Tour of Cold Neutron Research Facility	
4:15	Travel to Materials Building, Room B307	
4:30	Executive Session with MSEL Director (Materials Bldg., Room B307)	
5:15	Panel meets Compri van in front of Materials Building for ride to Compri Hotel	
6:15	Panel meets NIST van in front of Compri Hotel for ride to Flaming Pit Restaurant	
6:30	Social Hour and Dinner - Flaming Pit Restaurant. Division Chiefs, L. Schwartz, H. Rook, D. Butrymowicz, S. Schneider, and J. Early	
9:30	Panel members ride back to Hotel with Division Chiefs	

Friday, February 2, 1990

8:00 a.m.	Panel meets Compri van in front of Compri Hotel for ride to Administration Building, NIST
8:30	Executive Session (Panel Only) - Dining Room C Coffee and doughnuts available before and during the executive session
12:00 p.m.	Lunch with Division Chiefs and L. Schwartz, H. Rook, D. Butrymowicz, S. Schneider, and J. Early - Dining Room C
1:00	Panel Chairman meets with L. Schwartz and H. Rook Materials Building, Room B304
1:15	Panel meets Compri van in front of Administration Building for ride to Compri Hotel
2:00	Panel Chairman meets with NIST Director Administration Building, Room A1134

Panel members have an open schedule after lunchtime on Friday, Feb. 2.

Panel members requiring special arrangements to airport on Friday, February 2, should contact Dan Butrymowicz/Linda Luhn on Thursday, February 1.

OFFICE OF THE DIRECTOR

MATERIALS SCIENCE AND ENGINEERING LABORATORY

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PREFACE

The National Academy of Sciences-National Research Council (NAS-NRC) Board on Assessment of NIST Programs, and in particular, the Panel for Materials Science and Engineering, performs an important role in the programs and success of the Materials Science and Engineering Laboratory (MSEL). The Panel is one of our most effective means for assuring a continuous interaction between our staff and counterparts in the scientific and engineering communities of U.S. industry and academe. Each of the Panel members is selected by the National Research Council on the basis of expertise and extensive experience in the areas of research and technology conducted by the Laboratory. In addition to this Laboratory-wide Panel, we also have an Evaluation Panel for the Reactor Radiation Division.

The 1989 Annual Report was prepared for the NAS-NRC Board of Assessment of the MSEL. The Report contains background information on resources, activities, and representative highlights of the Laboratory. A second series of reports on detailed technical accomplishments are published separately as National Institute of Standards and Technology Internal Reports (NISTIR) for each Division/Office. These reports are available to members reviewing individual Divisions.

We look forward to your input and advice in both the evaluation and formulation process of our management decisions at all levels in the Laboratory. During this last year, I know that you have spent time in visiting our Laboratory and discussing programs, progress and plans with our staff. I appreciate the time that you give and look forward to working with you in the future.

Lyle H. Schwartz

December 26, 1989

OVERVIEW

OVERVIEW

I. Introduction

The Materials Science and Engineering Laboratory (MSEL) is responsible for providing the Nation with measurement methodology and technology, standards, concepts, reference materials, critically evaluated data, and other technical information on the fundamental aspects of processing, structure, properties, and performance of materials. These outputs are directed to the needs of U.S. industry, government agencies, academic institutions, and other scientific and technical organizations. The programs of MSEL support a wide base of generic technologies in materials, in order to provide their safe, efficient, and economical use in service. The research activities of the Laboratory address the science base underlying both advanced materials and conventional materials technologies, together with the associated measurement methodology.

The laboratory consists of five technical Divisions: Ceramics, Materials Reliability (located at our Boulder, Colorado laboratories), Polymers, Metallurgy, and Reactor Radiation; and one independent Office: Nondestructive Evaluation, which sponsors cross-cutting research throughout NIST. Our budget in FY 1989 was approximately $47 million, including capital equipment acquisitions. MSEL has a NIST staff of 380, of which 89 percent are in scientific or technical support positions. Seventy percent of our scientists and engineers have Ph.D. degrees. The average age of our full-time scientist and engineer staff is 46 years, the same as in 1987 and compared to 48 years in 1986. This maintains the age reduction achieved last year.

In addition to the NIST staff, we had 408 visiting scientists and engineers during 1989 involved in collaborative research or utilization of our special facilities (e.g., research reactor). These visitors represented U.S. industry, academe, other Federal agencies, and foreign institutions. Their stay at MSEL ranged from several weeks to the entire year, and their salaries and associated costs were covered by the parent organization.

II. Major Organizational and Programmatic Events

Continuing the recent trend, 1989 was another year of significant change for the staff of the National Institute of Standards and Technology (NIST) and for members of the Institute for Materials Science and Engineering (IMSE), now the Materials Science and Engineering Laboratory (MSEL). The signing of the Omnibus Trade and Competitiveness Act by President Reagan in 1988 significantly expanded the mission of the National Bureau of Standards and changed its name to NIST. This name change from a Bureau to an Institute necessitated a new name for IMSE and this past October, with approval from the Department of Commerce, the Institute for Materials Science and Engineering became the Materials Science and Engineering Laboratory.

An important change in NIST leadership was set in motion during 1989. NIST has been without a permanent Director since Dr. Ernest Ambler retired in April 1989. President Bush has recently nominated Dr. John Lyons, Director of the

NIST National Engineering Laboratory since its creation in 1977, to become the ninth Director. Dr. Lyons, a member of the National Academy of Engineering (NAE), came to NIST in 1973 as Director of the Center for Fire Research. Prior to entering Federal service, Dr. Lyons had a distinguished research and development career with the Monsanto Company. In recent years, Dr. Lyons has been an active participant in numerous NAE studies concerning emerging technologies, technology transfer, and technology issues related to international competitiveness. Confirmation is expected early in 1990.

During the past year, the Laboratory has continued to expand facilities and research opportunities in spite of the absence of new initiative funding for fiscal year 1989. The construction of the new buildings (guide hall, office/laboratory, and compressor building) for the Cold Neutron Research Facility (CNRF) was completed on time and within budget. The facility was dedicated by Secretary of Commerce Verity on January 12, 1989. The neutron guide tube installation began in June with the boring of seven holes through the more than seven meter thick concrete reactor confinement building wall and the subsequent installation of the first three guides. Commitments for instrumentation construction by industry and other non-NIST organizations totals in excess of $3.0M for three instruments. The CNRF Program Advisory Committee (PAC) met for the first time on October 24. The PAC will play a critical role in advising NIST on utilization of this national user facility, especially in areas of proposal solicitation, proposal review, scheduling periods, and accommodating users. With first year (FY 1988) funding from the high performance composites initiative, a strong start has been made in developing and equipping a polymer composites fabrication facility. Two processing methods, pressure molding and resin transfer molding, had been identified through an industry workshop as the most promising fabrication techniques for the future. Scheduled to be completed by the end of fiscal year 1990, many processing components will be operational early in 1990 for the preparation of well-characterized test samples and the investigation of processing science and on-line process control.

The Laboratory has further strengthened its programs through linkages with the private sector. Industrial collaboration has always been one of the major components of NIST's response to its mission. Passage of the Omnibus Trade Act has explicitly reinforced the importance of this outreach effort and of the benefits to the national economy derived from working closely with industry. Early collaboration with industry, often coupled with their scientists working directly with NIST staff, provides critical and timely information on industry's measurement-related problems and assures rapid transfer of research results from NIST programs. Through a series of internal and external actions, MSEL has taken the initiative in focusing industry and government attention on the concept of intelligent processing of materials using in-situ sensing and a computer-based approach to control the evolution of materials microstructures. In August, MSEL, the Department of Energy, and the American Iron and Steel Institute sponsored an industry-led workshop that focused on the role of intelligent processing and the sensor and process control needs for primary metals industries. The participants, approximately 75 senior technical staff and managers primarily from steel, aluminum, and copper companies, produced a report (NIST Special Publication 772) that highlighted advances in sensing, modeling, and process control and identified research needs in these areas. Research efforts in advanced process control sensors has resulted in the verification of proof of concept for a number of specific applications. Efforts to transfer these sensor concepts to the mill floor has led to substantial industry participation in field trials of sensor systems in production environments.

Programmatic objectives of these and other core programs of the Laboratory have been reviewed by the individual Divisional subpanels and executive summaries of their findings are presented in this report as an overview for all panel members. Selected highlights of this years' programs follow in a summary format. These highlights are representative of Laboratory programs but are not meant to be all-inclusive. A more comprehensive review of the individual Division's programmatic outputs are given in the Division's Annual Reports.

Selected Highlights

o A program of technology transfer with duPont has been initiated for the study of functionally terminated macromonomers. Copolymerization of macromonomers with conventional monomers has been studied and the resulting copolymers have been evaluated as radiation cured ink resins. The influence of macromonomers on the compatibility of crosslinked polymer networks has been explored by small angle neutron scattering.

o In collaboration with scientist at the Naval Surface Warfare Center, an optic-fiber fluorescence sensor has been installed at the exit die of a twin screw extruder. The sensor has been successfully used for in-situ monitoring of residence time distribution, quality of mix, and flow instabilities during polymer processing.

o Blends of linear protonated polystyrene and crosslinked deuterated polystyrene have been studies by small angle neutron scattering. It was found that linear chains can be incorporated into networks formed by sequential polymerization of the network surrounding the linear component if the network density is kept low. This result helps to explain why similar systems studied in the past at higher crosslink densities have almost always phase separated at some point during the synthesis.

o A patent was applied for on the use of microwave generated gas plasmas for sterilization of dental and medical instruments in as short a time as 1-2 minutes at temperatures near or below 60°C with no damage to the implements. Currently available sterilization techniques have a detrimental effect on the instruments or are not suitable for small clinics or private offices.

- A materials model for the three-dimensional time-dependent deformation of porous compacts being consolidated by hot isostatic pressing (HIPing) has been developed in a jointly funded DARPA/NIST program. The model is used to predict shape changes and has proven very successful in predicting the nonuniform shrinkage of HIPed copper powder and the densification behavior of intermetallic titanium aluminum.

- The NACE/NIST Corrosion Data Center expanded industry support for the development of knowledge-based expert systems using artificial intelligence concepts to aid in selection of materials for optimum corrosion resistance. A knowledge base expert system has been developed in cooperation with the New Zealand Department of Scientific and Industrial Research to provide materials selection advice for components in the downhole environments of oil and gas wells.

- A small-scale pilot plant designed to test new experimental concepts in high-speed electrodeposition of metals and alloys on monofilament high-strength fibers has been completed and used to produce small quantities of metallized fiber for evaluation. This NIST developed technology, demonstrated with copper, nickel, and cobalt tungsten, makes use of triaxial impinging jets of electrolyte to increase the deposition rate.

- Ultrafast signal-averaging (100 MHz) and optical multichannel spectroscopic capabilities were added to the NIST developed laser-induced vaporization mass spectrometric facility. These new techniques permit both mass and optical spectrometric techniques to be applied to the study of non-equilibrium processes occurring on the time scale of a few nanoseconds, such as from vapor plumes produced from refractory carbide and oxide targets.

- An assessment of failures in electric resistance welded (ERW) pipelines was completed and recommendations were made for implementing failure prevention and damage control procedures for pipelines in critical locations.

- Superconducting ceramics in the Bi-Pb-Sr-Ca-Cu-O system were produced from glasses through suitable crystallization heat treatments. The development of such glass-ceramic processing techniques could lead to better methods of forming complex shapes of these materials, such as producing fine superconducting wires by drawing glass fiber from the melt and heating to form the superconducting crystals.

- A thermomechanical method was discovered for producing untwinned single crystals of Y-Ba-Cu-O. The technique is based on the application of a compressive stress on parallel faces of a twinned crystal at elevated temperatures. The untwinned crystals show a sharp superconducting transition near a temperature of 90 K.

- The general validity of a model to predict the R-curve behavior of alumina ceramics has been confirmed by fitting the theory to indentation-strength data for a standard alumina with a well-characterized microstructure. Substantial flaw tolerance for alumina materials with large R-curves has been demonstrated.

- Prepared two major reports on the completed international round-robin on powder characterization involving physical and chemical properties (including particle size distribution, particle morphology, elemental composition, crystalline/noncrystalline phases, surface area, density, and other physical properties) of five powders.

- Processing techniques developed for studying residual stresses and distortions in ceramic-matrix composites have been applied to both whisker- and fiber-reinforced ceramics. Controlled oxide coatings applied to the fibers by sol-gel techniques have been shown to influence the initiation of sintering stresses.

- A PC-based system containing numerical data for tribology has been developed at NIST and is ready for release. This is the first such information system for tribology in the U.S. and consists of 368 records of different materials or test conditions in a format that contains 50 different information fields.

- A prototype ultrasonic instrument has been developed to nondestructively characterize the formability of thin steel sheet. The system uses electromagnetic-acoustic transducers (EMAT's) to generate and receive guided waves propagating at different angles in the sheet and good agreement has been found with destructive mechanical tests of sheet formability.

- In collaboration with Chrysler Motor Corp. and Chaparral Steel Co., the NIST thermomechanical processing (TMP) simulator was used to study the high-temperature high-strain rate flow characteristics and transformation kinetics of two direct-cooled microalloyed steels. The TMP was used as an instrumented forging press to develop the data needed for direct forging.

- An ultrasonic system for roll-by inspection of railroad wheels has been developed and is undergoing laboratory testing. The system, consisting of an electromagnetic-acoustic transducer (EMAT) embedded in the head of a rail, electronics for generation and reception of ultrasonic signals and for signal processing, and a lap-top computer for data collection and storage, predicts the size of any defects in the tread of the wheel and decides whether the defect is above or below a critical size.

- The Cold Neutron Research Facility (CNRF) buildings were completed, dedicated by Secretary of Commerce William Verity on January 12, 1989, and occupied in March. The neutron guide installation was begun by boring seven holes through the reactor confinement building.

- The Center for High Resolution Neutron Scattering (CHRNS) was established with a grant from the National Science Foundation (NSF). The Center will be built around two state-of-the-art neutron research instruments, a small-angle neutron scattering spectrometer and a spin-polarized inelastic neutron scattering spectrometer, to be designed and constructed by NIST with funding from NSF.

- The recently developed NIST/Sandia/ICDD diffraction database has been integrated by several manufacturers into their electron microscopy instruments to greatly enhance capabilities for materials characterization. The new database is also being extended to allow identification by full lattice matching.

- A new cooperative effort has been initiated with Sandia Laboratories to develop and apply high resolution cold neutron spectroscopy to the study of macromolecular and microporous materials.

RESPONSE TO 1988 PANEL CONCERNS

MSEL RESPONSES TO 1988 PANEL CONCERNS

This section reviews specific concerns raised by the MSEL Panel on Assessment in their 1988 Report. A more complete discussion of these concerns will be held during the 1989-1990 meeting.

CONCERN: "The additional mission given NIST by Congress will undoubtedly force changes in the organization and operation of NIST and IMSE. The Panel fears that the effort needed to communicate these changes to the scientific staff might have been underestimated."

RESPONSE: The Panel is correct in its assertion that changes in the NIST organization and operation will be profound. There has already been one reorganization, approved by the Department of Commerce and by Congress to realign technical strengths within the laboratory and to form the new Office of Technology Services. A more encompassing reorganization of NIST is currently being planned by the Director Designate. The Acting Director of NIST has held regular meetings with all of NIST management to describe the reorganization and its intended benefit to execute our new responsibilities. Communication with all staff will be imperative during the coming year.

CONCERN: "The Panel remains concerned about the apparent gradual shift away from the traditional role of NIST and IMSE as developer and keeper of measurement standards and data. .... The Panel recommends that the prior initiative be vigorously pursued to counteract this unfortunate shift."

RESPONSE: The MSEL management is equally concerned with the growing erosion of the financial resources available for measurement research, standards and data. Once again in FY 1990, initiatives to strengthen laboratory resources necessary to address those issues have been eliminated and base resources reduced due to Gramm-Rudman reductions and inflation. New initiative funding has been approved by the Office of Management and Budget for inclusion in the President's FY 1991 budget.

CONCERN: "The Panel is concerned that, in view of the new emphasis on industrial involvement, IMSE does not have a clear intellectual property rights position."

RESPONSE: The NIST management agreed with the Panel's concern about intellectual property. Dr. Schwartz chaired a NIST task group in developing new NIST policy options concerning patenting, government licence practices, and institutional and personal intellectual property. These options are currently being discussed by the Executive Board leading to a new NIST policy.

PERSONNEL

SUMMARY OF STAFF

Full Time Permanent	1987	1988	1989
Physicist	65	66	61
Chemist	45	46	43
Metallurgist/Matls. Scientist	39	47	54
Engineer	32	42	41
Other	3	9	12
Subtotal	184	210	211
Technical Support	35	32	32
Reactor Operators	16	15	16
Management Support	7	12	11
Secretarial	31	28	31
Subtotal	89	87	90
TOTAL FTP	273	297	301
Other			
NRC-NAS Postdoctorals	11	15	9
Part-Time and Temporary	46	29	27
Academic (Student and Faculty)	59	51	42
Subtotal	116	95	79
TOTAL STAFF	389	392	380

FY 1989 POSTDOCTORAL PROGRAM

Unit	Name	Degree	School	Position Title	Advisor
Polymers	Campbell, Gordon	Chemistry	Texas A&M	Chemist	VanderHart
	Coyne, Laurence	Pol Sci/Eng	U. of MA	Matls Res Engr	Wu
	Douglas, Jack	Chemistry	U. of Chic	Res Chemist	Han
	Duran, Randolph	Poly Sci	U. L. Past	Matls Res Engr	McKenna
	Jackson, C.	Poly Sci	U. of CT	Gen Phy Scient	McKenna
	Krueger, Susan	Physics	U. of MD	Res Physicist	Olson
	Nakatani, Alan	Matls Sci	U. of CT	Matls Scientist	Han
Metallurgy	Janowski, G.	Metall Eng	MI Tech U.	Metallurgist	Fields
	Sandlin, Allison	Matls Eng	U. of Ala	Metallurgist	Schaefer

FY 1989 ACADEMIC PROGRAM

Appointments

	Undergraduate Students	Graduate Students	Faculty	Totals
NDE	---	---	---	---
Ceramics	8	4	---	12
Fract & Defor	1	---	---	1
Polymers	10	2	3	15
Metallurgy	10	---	1	11
Reactor Radiation	1	---	1	2
Totals	30	6	5	41

VISITING SCIENTIST PROGRAM

Guest Researchers	FY 1987	FY 1988	FY 1989
Domestic			
Federal	34	52	54
Academic	66	104	79
Industry	42	28	29
Self-Employed	17	23	20
Subtotal	159	207	182
Foreign	129	74	136
Subtotal	288	281	318
Research Associates			
Federal	4	5	3
Academic	1	17	4
Industry	79	68	82
Subtotal	84	80	89
Intergovernmental Personnel Act (Academic)	2	1	1
TOTAL	374	362	408

HONORS AND AWARDS

DEPARTMENT OF COMMERCE AWARDS

1987-1989

GOLD MEDAL (Exceptional Service)

Arnold H. Kahn	for theoretical studies of electromagnetic field interactions with metals and alloys. (1988)
James J. Rhyne	for international leadership in critical research on advanced magnetic materials for high-technology products and devices. (1987)
Robb M. Thomson	for outstanding contributions as a world leader in the field of fracture in materials. (1987)

SILVER MEDAL (Meritorious Service)

Stephen W. Freiman	for outstanding research and leadership relating to the structure and processing of ceramic materials to final properties. (1987)
Joseph J. Ritter	for his continued contribution to innovative research in low-temperature synthesis of advanced ceramic precursors and starting powders. (1989)
Donald L. Hunston	for outstanding scientific and managerial leadership in the investigation of adhesion and the processing and performance of polymer composites. (1989)
E. Neville Pugh and Ugo Bertocci	for significant advances in the understanding of environment induced cracking of engineering metals and alloys. (1989

Reactor Operations Group	for excellence in all aspects of the operation of the NIST Reactor (1989)
Joseph J. Ritter	for pioneering research which led to novel routes for producing ceramic powders. (1988)
Antonio Santoro	for developing highly important theoretical and experimental methods for measurement of the structures of materials. (1988)
Haydn N.G. Wadley	for contributions to a program aimed at the development of sensors and their integration into automated control systems for materials processing. (1988)
Wen-li Wu	for the development of a unique and powerful technique for analyzing the molecular structure of polymers used in composites. (1987)

BRONZE MEDAL (Superior Service)

Barry J. Bauer	for outstanding contributions to the synthesis and characterization of cross-linked interpenetrating polymer networks. (1989)
Douglas Blackburn	for development of glasses or glass standards in support of the optical, analytical chemical, and glass industries. (1989)
John E. Blendell	for outstanding contributions and leadership in the development of processing high-temperature ceramic superconductors. (1988)
Yi-Wen Cheng	for development of a thermomechanical processing simulator. (1988)
Alfred V. Clark	for outstanding contributions to the nondestructive evaluation of materials and components. (1987)

Edmund A. Di Marzio	for outstanding theoretical contributions to the understanding of glass transition, polymer crystallization, non-exponential relaxation in amorphous materials, polymer interfaces, and structure induced phase transition. (1988)
Carol A. Handwerker	for providing new understanding of interface reactions and processes that cause roughening at interfaces in composite materials. (1989)
Paul A. Kopetka	for engineering design, supervision of fabrication, and the final testing and installation of the NIST cold neutron source. (1988)
Chia-Soon Ku	for development of oxidation measurements and standards for the Nation's petroleum and transportation industries. (1987)
Stephen D. Ridder	for outstanding contributions to the study of atomization processes in metals. (1988)
Gery R. Stafford	for contributions to the understanding of the electrochemical deposition of aluminum-titanium intermetallic compounds. (1988)
Robert H. Williams	for outstanding contributions to the development and operation of the research facilities at the NIST Reactor, and for his leadership in the planning and installation of instrumentation at the Cold Neutron Research Facility. (1989)

SPECIAL ACTS

Edward Begley	for contributions to the development of a computerized structural ceramics database. (1989)
Subhas Malghan	for leadership in formulating an industrially relevant program of research in fine ceramic powder processing. (1989)
Deborah Northup	for extraordinary facility in quickly assuming increased duties as secretary of a much larger group and efficiently carrying out the duties under unusual supervisory circumstances. (1989)

FELLOW AND SENIOR FELLOW (Established by NIST Director to provide recognition to most outstanding scientists)

John Cahn	Elected to Senior Fellow
Brian R. Lawn	Elected to Fellow
John J. Rush	Elected to Fellow
Robb M. Thomson	Elected to Fellow
Sheldon M. Wiederhorn	Elected to Senior Fellow

NIST AWARDS

1987-1989

CONDON (Distinguished achievement in written exposition in science and technology)

Gregory B. McKenna	for his excellent review of the properties and physics of polymer glasses. (1989)

EDWARD BENNETT ROSA (Outstanding achievements in the development of significant standards of practice in the measurement field)

Samuel J. Schneider	for outstanding contributions and leadership activities in developing and promoting standards in materials science and engineering. (1988)

SAFETY (Significant contributions to Safety Program)

Ralph F. Krause	for outstanding tenure as Ceramics Division Safety Officer, enhancing safety awareness and maintaining an excellent safety record. (1987)
John E. McKinney	for leadership of the safety program in the Polymers Division.

EXTERNAL RECOGNITION

1987-1989

L.H. Bennett	Sigma Xi Award (1989).
George Birnbaum	Appointed research professor in the Physics Department of the Catholic University of America (1989).
William Boettinger	Materials Science Division Award of ASM International (1989).
Edwin Fuller	Ross Coffin Purdy Award of the American Ceramic Society for his valuable contribution to the ceramic technical literature (1987).
Charles Guttman	Elected Fellow of the American Physical Society (1987).
Charles Interrante	George Kimball Burgess Memorial Award by the American Society for Metals for significant contributions to the field of metallurgy (1987).
David S. Lashmore	International Electrodeposition Award, Electrochemical Society (1989).
David S. Lashmore	Elected President of the Electrodeposition Division of the Electrochemical Society (1988).
Leonard Mordfin	ASTM Award of Merit and the title of Fellow of the Society for distinguished leadership and exceptional contributions in the promotion, development, and growth of the ASTM Committee on Mechanical Testing (1989).
M. Linzer, H. Wadley, D. Supperman (Argonne), L. Spivak (Magnaflux)	I-R 100 Award for development of an Ultrasound Pipe Porosity Sensor given by Research and Development magazine (1987).
Chris McCowan	Honorable Mention Award at the International Metallographic Contest, for his contribution, "Microstructural Characterization of Y-Ba-Cu-O Superconductors" (1988).
Gregory B. McKenna	Elected Fellow of the American Physical Society (1989).

Elio Passaglia	ASTM Award of Merit for outstanding contributions to the advancement of voluntary standardization (1987).
Marshall Peterson	The Mayo D. Hersey Award of the ASME, in recognition of his many contributions which led to an improved understanding of friction, wear, and lubrication of materials. (1988).
H.J. Prask and **C.S. Choi (Guest)**	Department of Army Research and Development Achievement Award; for developing and applying neutron diffraction to the determination of subsurface residual stress in a variety of military hardware (1989).
Richard P. Reed	Outstanding Scientist/Engineer Award from the Denver Federal Executive Board as part of its annual Excellence in Government Awards Program (1989).
Harry Rook	Elected Chairman of ASTM Committee D-22 Sampling and Analysis of Atmospheres (1989).
Harry Rook	Elected permanent Chairman of ISO TC 146 Subcommittee 3 - Committee on Standards for Atmospheres (1989).
Lyle H. Schwartz	Elected Fellow of ASM International (1987).
Dan Shechtman	International Prize for New Materials by the American Physical Society for his experimental discovery of phases of matter that exhibit icosohedral symmetry (1987).
Dominique Shepherd	First Place Award at the International Metallographic Contest, for her poster, "Advantages of Light Microscopy for Measuring Twin Dimensions in High-Temperature Superconductors" (1988).
Tom Siewert and **Christopher McCowan**	Recipients of the American Welding Society McKay-Helm Award. This award, recognizing a substantial contribution in the field of welding, was presented for their paper on ferrite phase prediction in stainless steel welds (1989).
Thomas Siewert	Selected as the annul recipient of the American Welding Society Honorary Membership Award (1989).
Thomas Siewert	Selected as the annual recipient of the American Welding Society Honorary Membership Award (1988).

Sheldon Wiederhorn	Dow Distinguished Lecturer in Materials Science and Engineering, Northwestern University, Department of Materials Science and Engineering, in recognition of his outstanding contributions to materials science and engineering (1988).
H. Thomas Yolken	Appointed editor-in-chief of ASNT's new journal, Research in Nondestructive Evaluation (1989).

TECHNOLOGY TRANSFER

CONFERENCE PROGRAM
(SPONSOR OR CO-SPONSOR)

FISCAL YEARS 1987, 1988, 1989

IMSE Symposium Series on Composites: Fracture Behavior of Fiber Reinforced, Ceramic Matrix, Composites
March 19, 1987 (S. Freiman-Ceramics)
40 attendees

New test techniques were described which can be used to quantitatively determine fiber/matrix interface properties and to ascertain the role of crack/fiber interactions in governing the strength of the composite.

Workshop to Establish Standardization Plan for Real-Time Radioscopy
April 2-3, 1987 (T. Siewert-Fracture and Deformation)
25 attendees

To enhance the quantitative capabilities of industrial real-time radioscopy and to make its measurements traceable to recognized standards.

NBS-BAM Symposium on Corrosion and Wear
April 13-14, 1987 (W. Ruff-Metallurgy)
50 attendees

To offer communication between staff of the two organizations on research programs and projects. In addition, other professional individuals are made aware of research activities.

Interagency Coordinating Committee on Structural Ceramics
May 6-7, 1987 (S. Hsu-Ceramics)
45 attendees

To coordinate central objective of various Federal agencies on structural ceramic programs.

Third Annual Heavy Section Steel Technology Program Workshop on Dynamic Fracture and Crack-Arrest Technology
May 13-15, 1987 (R. Fields-Fracture & Deformation)
65 attendees

Results from on-going dynamic-fracture and crack-arrest studies around the world will be presented and discussed to stimulate technology transfer to US industry.

Joint Services Technical Coordinating Group on Nondestructive Inspection (JRCG/NDI) Specifications and Standards Subgroup
June 1-2, 1987 (L. Mordfin-Nondestructive Evaluation)
12 attendees

To discuss progress and plans and to coordinate interagency efforts to develop new and improved military standards and specifications for nondestructive evaluation.

COMAT Subcommittee on Superconductors
June 12, 1987 (S. Dapkunas-Ceramics)
40 attendees

Coordination of Government Sponsored Research on High Temperature Superconductors

ONR/NBS Workshop on Surface Forces
September 2-3, 1987 (B. Lawn/S. Wiederhorn-Ceramics)
25 attendees

Discussions on the application of new measurement technique to materials science.

U.S.-China Symposium on Advanced Ceramics Materials
September 8-11, 1987 (S. Freiman-Ceramics)
50 attendees

To exchange scientific information on advanced ceramic materials.

Workshop for U.S. Participants in IEA/Annex II Interlaboratory Comparison of Powder Characterization Methods
September 15-16, 1987 (A. Dragoo-Ceramics)
12 attendees

Discussion of technical issues related to physical and chemical characterization of ceramic powders.

ISO/TC164, Standards for Hardness, Uniaxial, and Fracture Testing
September 14-25, 1987 (R. Fields-Fracture & Deformation)
60 attendees

To establish international standards for mechanical testing.

42nd MFPG Meeting - Technology Innovation - Key to International Competitiveness
September 15-17, 1987 (R. Shives-Fracture & Deformation)
75 attendees

To provide a forum for the discussion of improving the position of the United States in the world market through the utilization of technology innovation.

ASTM E-49 Workshop on Ceramic Specification for Property Databases

September 29, 1987 (C. Hubbard-Ceramics)
10 attendees

To develop draft guidelines for specification of advanced ceramics for entry into a proposed materials property database.

Polymer Composite Processing and Industries Workshop

October 7, 1987 (D. Hunston - Polymers Division)
50 attendees

To expand the use of polymer composites by analyzing the critical need for improved processing.

Materials Science Symposium

January 14-15, 1988 (L. Schwartz-Institute Office)
150 attendees

To honor the 60th birthday of Dr. John Cahn.

Fatigue Data Workshop

January 19-22, 1988 (H. McHenry-Fracture & Deformation)
35 attendees

Addressed the collection, documentation, evaluation, and dissemination of fatigue data. Reviewed existing databases in the United States, Europe, and Japan and discussed documentation standards to permit the interchangeability of fatigue data.

VAMAS Steering Committee Meeting

January 22-23, 1988 (L. Schwartz-Institute Office)
30 attendees

To host the annual meeting of the international VAMAS Steering Committee.

Engineered Materials for Advanced Friction and Wear Application

March 1-3, 1988 (A. Ruff-Ceramics)
200 attendees

Application of engineered material to tribological situations.

Workshop on Microstructure and Macromolecular Research with Cold Neutrons

April, 1988 (C. Glinka; J. Gotaas-Reactor Radiation)
160 attendees

To inform the scientific and industrial community about the new cold neutron research capabilities at the CNRF and allow them to participate in the design and scientific planning of this new national center.

Low Temperature Structural Materials and Standards Workshop
May 26-27, 1988 (R.P. Reed-Fracture & Deformation), Tokyo, Japan
33 attendees

Establish international standards and test methods for structural alloys at liquid helium temperature to support the development of superconducting fusion energy magnet devices.

Gordon Research Conference on Tribology
June 20-24, 1988 (S. Hsu-Ceramics)
130 attendees

Review of most recent research in the field of tribology.

Conference on Thin Film Neutron Optical Devices
August, 1988, San Diego, CA (C. Majkrzak-Reactor Radiation)
50 attendees

Part of a symposium by the International Society for Optical Engineering to present and discuss the latest results in supermirrors, multilayer monochromators, polarizers and beam guides which are a key to the development of future cold neutron and x-ray scattering instrumentation.

Workshop on Intelligent Processing of Materials
August 30-September 1, 1988 (T. Yolken-Office of Nondestructive Evaluation)
56 attendees

To define the specific materials processes upon which the NIST Program should focus and to discuss suitable approaches for accomplishing the work.

NIST Workshop on Intelligent Polymer Processing
August 31-September 1, 1988 (A. Bur-Polymers Division)
25 attendees

To assess the needs of the U.S. polymer processing industry in developing inteligent polymer processing technology.

Mechanical Failures Prevention Group - 43rd Meeting, "Advanced Technology in Failure Prevention"
October 3-6, 1988 (T. Shives-Metallurgy), San Diego, CA
120 attendees

Technical symposium on techniques for failure analyses and prevention.

Conference on Model Instrumentation and Analysis Techniques
October 6-8, 1988 (J. Tesk-Polymers)
50 attendees

Conference co-sponsored by NIST and Academy of Dental Materials to provide a useful overview of the dental materials researchers on the application and use of some modern measurement and analysis techniques.

Materials Science of High T_c Superconductors: Magnetic Interactions
October 11-13, 1988 (L. Bennett-Metallurgy) (Co-sponsored by NASA)
85 attendees

Technical symposium on recent advances in production and testing of high temperature superconductors.

Computerization of Welding Information
October 19-21, 1988 (T. Siewert-Fracture & Deformation)
63 attendees

Review the recent advances in software for welding application and develop a list of user needs to guide future software development.

Eleventh Cryogenic Structural Materials Workshop
October 18-19, 1988 (R.P. Reed-Fracture & Deformation), Colorado Springs, CO
50 attendees

To review, identify, and discuss important issues relevant to the advancement of structural devices for fusion energy developments.

4th U.S.-Japan Workshop on Dielectric and Piezoelectric Materials
October 30-November 2, 1988 (S.W. Freiman-Ceramics)
35 attendees

The main purpose of this workshop was to inform U.S. researchers on some recent Japanese research developments in dielectrics and piezoelectrics, The workshop also addressed topics in electrooptics, substrates and packaging, and superconductors.

Four U.S.-Japan Workshops on Dielectric and Piezoelectric Materials
October 31-November 2, 1988 (S. Freiman-Ceramics)
75 attendees

Cooperative summary of research results on electronic materials.

Workshop on Neutron Methods for High T_c Superconductors
November 3-4, 1988 (J. Stalick-Reactor Radiation)
30 attendees

Review of neutron methods as applied to superconductor characterization.

Commemerative Conference to Celebrate the 75th Anniversary of the Founding of the Metallurgy Division of NIST
November 10, 1988 (E.N. Pugh-Metallurgy)
120 attendees

To recognize historic significances of the founding of the Metallurgy Division.

Elastic Anisotropy in Composites
December 5, 1988
20 attendees

This seminar described a test-bed for the investigation of anisotropic media, such as composites.

Polymers West Gordon Conference
January 1-6, 1989, Ventura, CA (E. DiMarzio-Polymers)

International meeting devoted to "Phase Transition in Polymers" with an emphasis on self-assembling systems.

Workshop on Solidification and Microstructure Evaluation
February 2, 1989 (J. Simmons-Metallurgy)
15 attendees

Technical symposium on NDE methods to evaluate microstructure in metallic structures.

Nonconventional Ultrasonic Instrumentation and Methods in Nondestructive Evaluation of Composite Materials and Structures
February 15, 1989 (H.T. Yolken-NDE)
20 attendees

In this seminar, three nonconventional techniques are described: air-coupling to materials that should not be immersed, high-power ultrasonics to inspect "thick" structures, and broadband signals to measure the frequency dependence of attenuation and velocity.

Engineering Foundation Conference on Structural Ceramics - Science and Technology
March 12-17, 1989 (S. Wiederhorn-Institute Office)
54 attendees

The purpose of this conference was to assess the current state of the art/science in structural ceramics with a particular emphasis on automotive and truck applications. Areas for future research, both basic and applied, were identified.

Materials Aspects of High-Temperature Superconductivity
March 20-24, 1989 (E.R. Fuller, Jr.-Ceramics)
240 attendees

These were special focussed sessions organized for the materials Physics Topical Group and the Division of Condensed Matter Physics as part of the 1989 March Meeting of the American Physical Society held in St. Louis, Missouri.

Alternatives in Glass Research Symposium

March 23, 1989 (M. Cellarosi-Ceramics)
15 attendees

This meeting focused on the critical research issues and alternatives in the glass industry. The meeting was co-sponsored with the Industry University Center for Glass Research at Alfred University (CGR), which comprises industrial interests planning to confront head on the problems facint their industry - competition from foreign manufacturer, competitive materials, and use of glass in high technology applications.

Sixth International Conference on High Temperatures

April 3-7, 1989 (J.W. Hastie-Metallurgy)
150 attendees

Technical symposium on high temperature chemical reactions

Advanced Composite Materials Characterization and Test Methods; NIST-ASM

April 5-6, 1989 (R.E. Rickers-Metallurgy)
60 attendees

Short course on composite properties.

Description of NDE Research and Services Atomic Energy Research Establishment

April 6, 1989 (H.T. Yolken-NDE)
20 attendees

AFOSR Program Review

April 10-11, 1989 (D. Cranmer-Ceramics)
55 attendees

The purpose of this conference was to review the status and future plans of the current efforts of AFOSR contractors in the ceramics and non-metallics structural materials area. An assessment of future research program areas of interest to AFOSR was also made.

American Chemical Society Symposium on Tribology

April 10-11, 1989 (S.M. Hsu and J. Perez-Ceramics)
50 attendees

The symposium covered several areas in tribology including the use of fractals, surface chemistry and lubrication mechanisms. It was held in the honor of Professor Elmer Klaus who has made significant contributions to lubrication in the past 45 years.

American Chemical Society - Special Symposium on Chemistry and Chemical Engineering in Tribology

April 12, 1989 (S.M. Hsu-Ceramics)
60 attendees

The objective of this symposium was to explore the current state-of-the-art in chemistry at interface.

Society of Tribologists and Lubrication Engineers Annual Meeting
May 1-4, 1989 (S. Jahanmir-Ceramics)
1400 attendees

This is the largest Tribology technical meeting which is held every year. It brings together a large number of people involved in various aspects of tribology, including research, education, sales, marketing, and development. It also includes an industry exhibit.

Third International Conference on Fundamentals of Fracture
May 26-June 16, 1989, Trieste, Italy (Robb Thomson-Institute Office)
30 attendees

Workshop organizers through the auspices of the International Centre of Theoretical Physics on the subject on fundamentals of fracture.

Second International Conference on Hot Isostatic Pressing - Theory and Applications
June 7-9, 1989 (R.J. Schaefer-Metallurgy)
115 attendees

Technical symposium on advances in hot-isostatic pressing.

Third International Conference on Fundamentals of Fracture
June 19-24, 1989, Irsee, W. Germany (Robb Thomson-Institute Office)
120 attendees

This conference explored the developments on fracture fundamentals for the last three years. Participants were from the disciplines of mechanics, physics, chemistry, metallurgy and ceramics

TTCP Ceramic Matrix Composites Workshop
June 22-23, 1989 (D. Cranmer-Ceramics)
15 attendees

The purpose of the workshop was to assess convenient and affordable room temperature test techniques for measuring tensile, compressive, and shear strength of ceramic composites. A second objective was to provide some initial, reliable values of these strengths.

VAMAS Steering Committee Meeting
June 28-30, 1989 (L. Schwartz-Institute Office)
30 attendees

To host the annual meeting of the International VAMAS Steering Committee

SDIO/IST-ONR Diamond Technology Initiative Symposium
July 11-13, 1989 (Albert Feldman-Ceramics)
305 attendees

Annual meeting sponsored by the SDIO for rviewing the state-of-the-art in all aspects of CVD diamond technology.

Superconductor and Related Materials Session, 1989 Annual Meeting of Crystallographic Association
July 24-29, 1989 (W. Wong-Ng-Ceramics)
80 attendees

This session reviewed current results of studies of the crystallography of high temperature superconductors.

Photothermal Techniques from Technology to Basic Physics
August 4, 1989 (G. Birnbaum-NDE)
20 attendees

This seminar introduced various possibilities of the photothermal detection technique for the nondestructive characterization of materials and systems.

Symposium on Diamond Optics II, at 33rd Annual International Technical Symposium on Optical and Optoelectronic Applied Science and Engineering
August 7-8, 1989 (Albert Feldman-Ceramics)
100 attendees

This meeting was the principal SPIE meeting concerned with diamond as an optical material. It covered both the fundamental aspects of CVD diamond processing, structure and properties as well as applications of diamond and diamondlike carbon.

Intelligent Sensors for Atomization Processing of Molten Metals and Alloys
August 28, 1989 (L. Mordfin-NDE)
20 attendees

This seminar introduced the principles of atomization processing of molten metals and alloys and proposed opportunities for developing intelligent sensors for monitoring and control of the process.

Intelligent Processing for Primary Metals
August 29-30, 1989 (James Early-Institute Office)
76 attendees

Reviewed recent advances in sensing, modeling, and process control, identified areas of need in the primary metals industries, and developed a strategy for implementation of research results.

NIST/ONR Workshop on Fracture Computations
September 7-8, 1989 (G.S. White-Ceramics and R.M. Thomson-Institute Office)
25 attendees

The purpose of this workshop was to review the current status of electronic-, atmosistic-, and micro-scale models for describing the fracture of brittle materials.

Symposium on Applications of Probability Theory to Polymer Science
September 18-19, 1989 (J. Douglas-Polymers)
76 attendees

Symposium sponsored by the Polymers and Applied Mathematics Division of NIST. Methods such as path integrals, fractals, Levy statistics and linear response theory were applied to polymeric problems and to membranes.

STANDARDS COMMITTEES MEMBERSHIP

Unit	Staff
Institute Office	5
Nondestructive Evaluation	1
Ceramics	17
Fracture & Deformation	10
Polymers	12
Metallurgy	17
Reactor Radiation	2
	64*

*Includes: 26 chairs
2 secretaries
1 director

Representation

Organization

American National Standards Institute
American Nuclear Society
American Society for Mechanical Engineers
American Society for Testing and Materials
Department of Defense/Technical Coordination
Electronic Industries Association
International Institute of Welding
International Organization for Standardization
Joint Committee on Powder Diffraction Standards
National Association of Corrosion Engineers
Safety Glazing Certification Council
Welding Research Council

Source: Directory of NBS Standards Committee Activities, 1989.

RESEARCH DISSEMINATION
FY 1989

UNIT	PAPERS PUBLISHED	TALKS INVITED	PATENTS*	SRMs*	MONOGRAPHS*
INSTITUTE OFFICE	16	36	---	---	---
OFFICE OF NONDESTRUCTIVE EVALUATION	8	10	---	---	---
CERAMICS	121	200	8	3	---
FRACTURE AND DEFORMATION	95	22	1	1	---
POLYMERS	151	124	2	2	---
METALLURGY	135	106	3	---	2
REACTOR RADIATION	152	35	---	---	---
TOTAL	678	533	14	6	2

*Listing on following page.

Patents Received or Pending
1987-1989

1987

Stress-free Sintering of Fiber-Reinforced Ceramic Composites
Claudia Ostertag (Ceramics)

Quantitative and Qualitative Technique for Assessing Stresses During Densification of Composites
Claudia Ostertag (Ceramics)

A Hermetically Sealed Inert Atmosphere Cell for X-ray Powder Diffraction
Joseph J. Ritter (Ceramics)

Superconducting Ceramic Composites
Stephen W. Freiman (Ceramics)

Hydrophobic Dental Composites Based on a Polyfluorinated Dental Resin
J.M. Antonucci (Polymers)

Interpenetrating-Network Polymeric Electrolytes
B.J. Bauer, C.K. Chiang, G.T. Davis (Polymers)

Method for Obtaining Strong Adhesive Bonding of Composites to Dentin, Enamel, and Other Substrates
R.L. Bowen (Polymers)

Simplified Method for Obtaining Strong Adhensive Bonding of Composites to Dentin, Enamel, and Other Substrates
R.L. Bowen (Polymers)

Transducer Hydrophone with Filled Reservoir
G.R. Harris and A.S. DeReggi (Polymers)

Arc-Furnace for the Production of Small Investment Castings
R.M. Waterstrat (Polymers)

Method for Determining Subsurface Property Value Gradients
H.N.G. Wadley (Metallurgy)

Automated Device for Determining and Evaluating the Mechanical Properties of Materials
D.S. Lashmore, J.L. Mullins, C.E. Johnson, R. Polvani (Metallurgy)

1988

Aluminum Hydroxides as Solid Lubricants
Applied For
R. Gates, S. Hsu (Ceramics)
High Pressure Process for Producing Transformation Toughened Ceramics
Patent No. 4,771,022, September 13, 1988
S. Block, G. Piermarini (Ceramics)

Fibrous Monolithic Ceramic and Method for Production
Patent No. 4,772,524, September 20, 1988
W. Coblenz (Ceramics)

Ultraviolet Transmitting Glass for 308 nm Ring Dye Laser
D. Blackburn, D. Kauffman, D. Cranmer (Ceramics)

Novel Process for the Preparation of Fiber Reinforced Ceramic Matrix Composite
W. Haller, U. Deshmukh (Ceramics)

Dielectric Phantom Material
Applied For
M. Broadhurst, C. Chiang, G. Davis (Polymers)

Superconductor - Polymer Composites
Applied For
A. DeReggi, G. Davis, C. Chiang (Polymers and Ceramics)

Oligomeric Adhesives
Applied For
G. Brauer; C. Lee (Polymers)

Radiopaque Polymers Useful as Components for Radiopaque Materials
Applied For
G. Brauer, J. Stansbury, J. Tesk (Polymers)

Polymeric Denture Reline Materials
Applied For
R. Muller, J. Antonucci (Polymers)

Intaglio Ink Resins Which Cure by Oxidation in Air
Applied For
B. Dickens, B. Bauer (Polymers)

Method of determining subsurface property value gradient
Patent No. 4,765,750 - August 23, 1988
H.N.G. Wadley (Metallurgy)

Concentration Gradient Alloys
Filled October 1988
D.S. Lashmore and M.P. Dariel (Metallurgy)

Trivalent Chromium
Issued October 1988
D.S. Lashmore, E. Weisshaus, E. Namgoong (Metallurgy)

New Matrix Approach to Crystal Symmetry
In Process
A. Mighell; V. Himes (Reactor Radiation)

1989

Buffered Cell for Sintering of High Tc Thallium Containing Ceramics
Disclosure filed
L. Cook (Ceramics)

Coating of Reinforcing Agents of Ceramic Composites by Colloidal Processing
Disclosure filed
S. Malghan (Ceramics)

Self Lubricating Ceramic Matrix and Metal Matrix Composite
Disclosure filed
M. Peterson, A. Ruff, S. Jahanmir (Ceramics)

A Process for the Fabrication of Ceramic Monoliths
(By Laser Assisted CVI)
Disclosure filed
J. Ritter (Ceramics)

Ultraviolet Transmitting Glass for Ring Dye Laser
Disclosure filed
D. Blackburn, D. Cranmer, D. Kaufman (Ceramics)

Diamond Coated Infrared Transmitting Optics
Disclosure filed
A. Feldman, E. Farabaugh (Ceramics)

A Process for the Controlled Preparation of a Composite of Ultra-Fine Magnetic
Homogeneously Dispersed in a Dielectric
Disclosure filed
J. Ritter (Ceramics), R. Shull (Metallurgy)

Systems for Monitoring Changes in Elastic Stiffness in Composite Materials
Patent No. 4,499,770, February 19, 1985
R. Kriz (Fracture and Deformation)

Microwave Sterilizer
Applied For
J. Tesk, W. deRijk (Polymers)

Calcium Metaphosphate Fillers for Dental Materials
Applied For
J. Antonucci, S. Venz, B. Fowler (Polymers)

Trivalent Chromium Deposition
Patent No. 4,804,446, February 14, 1989
D.S. Lashmore, E. Namgoong, I. Weishaus (Metallurgy)

Graded Interfaces
Applied For
D.S. Lashmore and M. Dariell (Metallurgy)

Nanocomposite Material for Magnetic Refrigeration
Applied For
L.H. Bennett, R.D. Shull, L.J. Swartzendruber (Metallurgy)

SRMs PRODUCED
1989

SRM 1836 Total Nitrogen in Base Oils
(Ceramics)

SRM 674A X-Ray Diffraction Intensity Set
(Ceramics)

SRM 1817B Lub Oil Oxidation Test Kit
(Ceramics)

SRM 2092 and 2096 Charpy V-Notch Calibration Specimens
(Fracture and Deformation)

SRM 1487 A Low Molecular Weight Poly(Methyl Methacrylate), PMMA, Certified for Molecular Weight
(Polymers)

SRM 1474 A Standard Reference Polyethylene Material for Melt Flow Rate
(Polymers)

MONOGRAPHS
1989

Proceedings of the 41st Meeting of the Mechanical Failures Prevention Group - "Detection, Diagnosis, and Progress of Rotating Machinery to Improve Reliability, Maintainability, and Readiness Through the Application of Innovative Techniques"
T.R. Shives (Metallurgy), Published by Cambridge, Univ. Press, 1989

Proceedings of High-Tc Superconductors Magnetic Interactions, Edited by; L.H. Bennett (Metallurgy), Y. Flum, and G.C. Vezzeli, World Scientific Publishing Co., 1989

APPENDICES

1989 PANEL MEMBERS

Dr. Francois A. Padovani,
Chairman (1990)
Vice President
Materials and Controls Group
Texas Instruments Incorporated
34 Forest Street, Mail Station 10/13
Attleboro, MA 02703
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Prof. Robert E. Green (1992)
Materials Science and Engineering
Department
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Dr. Edmund G. Henneke, II (1990)
Head
Department of Engineering Science
and Mechanics
Virginia Polytechnic Institute
and State University
Blacksburg, VA 24061
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Dr. Ian F. Hughes (1990)
Director, Product Research
Inland Steel Corporation
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Dr. Peter Juliano (1991)
Manager, Polymer Physics and
Engineering Laboratory
General Electric Corporate
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Prof. Bernard H. Kear (1990)
Dept. of Mechanics and
Materials Science
College of Engineering
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(201) 932-2245

Dr. Robert A. Laudise (1992)
Director
Materials Chemistry Research Lab
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Dr. Neil Paton (1992)
Program Manager
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Rocketdyne Division
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R. Byron Pipes, Dean (1991)
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Dr. Arthur L. Ruoff (1992)
Professor of Materials Science
and Engineering
Department of Materials Science
and Engineering
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Dr. Maxine L. Savitz (1990)
Director, Ceramic Components Div.
Garrett Processing Company
19800 South Van Ness Avenue
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Dr. Richard S. Stein (1991)
Commonwealth Professor of Chemistry
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Dr. Cecil M. Teller (1992)
President
Texas Research Institute/Applied
Research and Technology Inc.
415 Crystal Creek Drive
Austin, TX 78746-4725

Dr. Charles M. Vest (1991)
Provost and Vice President for
Academic Affairs
3068 Fleming Administration Bldg.
University of Michigan
Ann Arbor, MI 48109-1340
(313) 764-9290

Prof. Julia R. Weertman (1990)
Chairman, Panel for Reactor Radiation
Department of Materials Science
and Engineering
Northwestern University
Evanston, IL 60201
(312) 491-5353

Dr. Albert R.C. Westwood (1991)
Vice President
Research and Development
Martin Marietta Corporation
Martin Marietta Laboratories
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Baltimore, MD 21227
(301) 247-0700

DRAFT

APPENDIX B

An Assessment of the Institute for Materials Science and Engineering

Panel Members

Francois A. Padovani, Texas Instruments Inc., Chairman
Ian F. Hughes, Inland Steel Company
George R. Irwin, University of Maryland
Peter Juliano, General Electric Corporate Research and Development
Bernard H. Kear, Rutgers University
G. S. Kino, Stanford University
Robert A. Laudise, AT&T Bell Laboratories
John P. McTague, Ford Motor Company
John L. Mihelich, Commonwealth Aluminum Corporation
Joseph N. Panzarino, Norton Company
R. Byron Pipes, University of Delaware
Maxine L. Savitz, Garrett Processing Company
Richard S. Stein, University of Massachusetts
Julia R. Weertman, Northwestern University
Albert R.C. Westwood, Martin Marietta Corporation

This report submitted for the Panel by the Chairman, Francois A. Padovani, is an annual assessment of the activities of the Institute for Materials Science and Engineering (IMSE), based on a meeting of the Panel on February 2-3, 1989, and the IMSE Annual Report.

Functions of the Institute

The Institute for Materials Science and Engineering, a major organizational unit of the National Institute of Standards and Technology (NIST), provides measurements, data, standards, reference materials, concepts, and other technical information fundamental to the processing, structure, properties, and performance of materials. This technology is used by industry, government agencies, universities, and scientific organizations. Much of the technology is generated and disseminated through cooperative programs with industry, which ensures rapid application and provides IMSE managers with immediate information on industry's needs for measurement science and data. For example, IMSE, jointly with the American Society for Metals (ASM) International and the American Ceramic Society, is evaluating and disseminating phase diagrams. Professional societies provide program guidance, research associates, and substantial financial support from industry. Also, IMSE is collaborating with the National Association of Corrosion Engineers (NACE) to provide the nation's scientists and engineers a much needed corrosion data center.

Research programs of IMSE create generic technologies in materials in order to foster safe, efficient, and economical use of materials. IMSE research addresses material science bases underlying advanced technologies. Rapid solidification of metals, ceramic processing, alloy coatings of steel, polymer blends, and advanced composites are current examples. IMSE has a beam line at the Brookhaven National Synchrotron Light Source for frontier research in materials transformations, kinetics, and x-ray optics. IMSE makes its unique facilities available to qualified engineers and scientists, usually from industry and universities, for cooperative research. Unique facilities include the research reactor and associated instrumentation, laboratories for preparation and characterization of rapidly solidified metals, and many other state-of-the-art measurement facilities. IMSE collaborates extensively with other NIST organizations in a wide range of interdisciplinary programs.

During fiscal year 1989, the IMSE had a staff of about 392 and a total operating budget of approximately $47.0 million.

Summary of Assessment

Institute for Materials Science and Engineering Overview

Quality of staff and research are excellent. Expansion by Congress of the National Bureau of Standards (NBS) mission to include development and implementation of manufacturing technologies that would make American industry more competitive in the world markets recognizes the relevance and excellence of the NIST.

Although not solely a technical feat, completion on time and under budget of the cold neutron facility is proof of the professionalism and competence throughout the IMSE organization.

Achievements and initiatives in metals, ceramics, polymers, and composites are positive proof of excellent performance of IMSE divisions.

Modification of the review procedure this year established a subpanel for each division. This arrangement significantly improved the annual review. Subpanel reports were reviewed at the Panel meeting. Activities of the Office of Nondestructive Evaluation (NDE) and the Reactor Radiation Division (RRD) were reviewed by separate panels.

Fracture and Deformation

Research on fracture and deformation improves structural safety and fosters applications of advanced materials. Research includes fracture mechanics, NDE, and welding. Improvements in deformation-processing methodology and on-line quality sensors improved the processing and characterization of advanced materials. Deformation and fracture studies based on solid-state physics and dislocation mechanics provide basic understanding of structure and physical properties of advanced materials and the impact of imperfections.

Composite materials currently being characterized have an epoxy matrix and graphite fibers. The goal is to develop the methodology for assessing structural damage using NDE measurements and analytical modeling. The tendency of damage in composites of this kind to be scattered rather than localized suggests a need for special attention to damping phenomena. Complexities of such research are challenging, and successful research will assist U.S. industries.

Proof-of-concept experiments were conducted for a novel nondestructive, on-line formability sensor for steel sheets. These experiments extend similar research on aluminum sheets in collaboration with the Advanced Steel Processing and Products Research Center (ASPPRC) and the Colorado School of Mines. Current industrial practice is destructive, time-consuming, and only applicable to off-line situations.

Metallurgy

Metallurgy Programs are traditional measurement science, materials characterization, data, and standard reference materials (SRMs), but have undergone radical changes over the past few years. In response to the congressional mandate to assist in increasing the nation's industrial competitiveness, current emphasis is on process sensors and, in some instances, process modeling and automated control.

Focus is believed to be correct for materials processing: synthesis, intelligent processing, and metal matrix composites. Synthesis of modern materials is more and more using a powder process to attain greater flexibility in composition and microstructure control. Ceramics and Polymers Programs have a similar approach. The Panel believes that enhanced interaction on a national scale with counterpart scientists could significantly accelerate this work.

Intelligent processing of materials is necessary for a competitive U.S. industry. The Advanced Sensing Program has made significant achievements in fundamental understanding and in collaboration with industry. Developments of eddy-current sensors for measuring the temperature of extrusion bars for the Aluminum Association and ultrasonic temperature measurement of steel for the American Iron and Steel Institute (AISI) appear to be quite successful.

Metal matrix composites achieve physical properties otherwise unachievable using conventional metals and their alloys. Development of an engineering database is of utmost importance.

Finally, a special note concerning small but excellent electrodeposition program. There is little doubt that this program is the best of its kind in the nation. Progress in synthesis of artificially layered materials is remarkable. Controlling the wavelength of the modulation down to 1 nm is an extraordinary achievement.

Polymers

The Polymers Programs provide traditional standards, measurements, and fundamental concepts of polymer science. This assists the U.S. industries that produce, process, or use synthetic polymers. The program is sensitive to industrial trends and anticipates future needs. This is the first year of congressional funding for research in high-performance composites.

Quantity and quality of technical accomplishments continues to be significant. The Polymers Program is probably one of the four strongest polymer physics groups in the United States.

Some highlights during the past year include:

Planning and gaining approval of a Composite Program in the present budget climate. An industry workshop on polymer composite processing was held with attendees representing users, fabricators, and suppliers of composites in the automotive, electronics, aerospace, and other industries. Based on recommendations from the workshop, autoclave and transfer molding were selected for prime attention. Implementation is under way, and necessary equipment is expected to be operable within the next year. The Composites Program is already yielding fundamental information that should lead to improved materials. For example, molecular structure and toughness of a model epoxy system were modified by varying the processing parameters. For a given composition, toughness was found to correlate with compositional fluctuations measured by small-angle, x-ray scattering (SAXS). These compositional fluctuations can be controlled by changing the processing parameters so that optimum toughness can be obtained without sacrificing other useful properties such as stiffness or glass transition temperature.

Intelligent processing program is creating opportunities to improve the competitiveness of processors and users of polymer products. A sensor was designed to measure velocity, velocity gradients, and flow instabilities in polymer processing. A mathematical model was formulated. Sensor operation is based on fluorescence recovery after photobleaching.

Small-angle neutron scattering (SANS) was used to measure phase behavior during mechanical mixing of polymer blends. Thus equilibrium phase diagrams and phase separation kinetics previously developed in the division are made relevant to the engineering process design problems faced by industry.

A constitutive equation was developed that describes for the first time the nonlinear mechanical response in a stress realization experiment for a semicrystalline polymer.

Certification measurements were completed for a polymethylmethacrylate, SRM 1487. Produced with partial support from the U.S. Navy, this SRM will provide quality control of antifouling paints and acrylic polymers.

A polyurethane SRM, jointly funded with the Food and Drug Administration, is under development for the biomedical device industry.

Ceramics

The Ceramics Programs provide scientific understanding, measurement methods, reference data, and materials used by U.S. industry to process advanced ceramics. Work is in structural, electronic, and optical ceramics. The current organization of the Ceramics Programs and description of activities has created a distinction between "structural" and "functional" ceramics; believed by the Panel to be somewhat artificial; however, the organization is responsive to the enlarged charter of NBS as the National Institute of Standards and Technology. Overall, the Panel is pleased with the program's progress and momentum.

Among many accomplishments in Ceramic Powder Synthesis, Characterization, and Processing Program, a special note is given to the huge compilation task of the International Energy Agency (IEA)/Annex II on powder characterization and the improved synthesis of superconductive precursors. Also worthy of note are a series of x-ray standards and a new Fourier transform infrared (FTIR) method for rapid-phase determination of silicon nitride. Such progress, will help eliminate key technical bottlenecks facing industry.

Good progress was made in determining mechanical properties of ceramics at room and high temperatures. Test methods are being developed for nonoxide and oxide ceramics. Instrumental indenture capability and correlation with single-fiber pull-out tests were demonstrated.

Wear maps of ceramics (alumina is complete; silicon nitride is 50 percent complete) were established. These maps help understand wear mechanisms and establish predictive models. Studies on alumina indicated that wear rate decreases as grain size is reduced.

Phase equilibria determination for high critical temperature (HTc) superconductors is best in the world and provides a competitive edge to U.S. superconductor researchers. Plans to study the effect of texture on HTc play to NIST's strengths. This valuable information is not likely to be generated as rapidly and effectively anywhere else. Also, the capacitor, piezoelectric, IR, and NDE projects work are well conceived and managed.

IMSE is a world leader in hot filament chemical vapor deposition (CVD) diamond growth and makes good use of diamond films in establishing characterization techniques.

Methods were developed for revealing micro a-b twining in gallium arsenide (GaAs) and providing "topographic" maps of texture in ceramics.

Progress in setting up and debugging a database system for a narrow area of structural ceramics is significant. Upgrading this system to be more user-friendly will go a long way toward a truly generic ceramic materials database.

Reactor Radiation

This includes a national center for characterizing advanced materials, a 20-MW research reactor, diverse programs in materials research, and extensive collaboration with other NIST divisions and outside scientists and engineers from industries and universities and other government laboratories. A primary goal is maximum utilization of the reactor radiation facilities and staff as a national resource for U.S. science and technology.

Particularly promising is the use of neutron reflectometry to characterize polymer interfaces.

Extended periods of reactor down time were necessary to install the cold neutron facilities. The cold neutron guide hall was completed, within budget, and on time. The RRD team should be proud of this accomplishment due in large part to the leadership of J. M. Rowe.

1989 was a milestone year for the RRD. Completion and dedication of the Cold Neutron Research Facility signal a strong, productive future for the division. The many years of dedicated leadership of Robert S. Carter, dating back to the installation of the NBS Reactor, were critical to the creation, maintenance, and enhancement of this research facility, and NIST is greatly in his debt at this time of his retirement. Fortunately, he will continue to advise RRD, and is succeeded by a world-class scientist and administrator, J. M. Rowe.

Nondestructive Evaluation

The Office of Nondestructive Evaluation (ONDE) manages an NIST-wide program for nondestructive testing (NDT), evaluation of materials using NDE methodology, and materials processing based on NDE, and developing NDE standards and methods. ONDE is currently managing: programs on ceramic and metal powder production and consolidation, formability of metals, and composites processing and interfaces.

ONDE made a good start on evolving basic sensors for powder metallurgy. ONDE used optical sensors to measure powder diameter and, for the first time, detected a shock front associated with the fluid flow and measured the front's role in the process for producing powders.

A simple eddy-current technique demonstrated that the temperature of an aluminum rod can be measured with good accuracy during the process of extrusion. The Panel suggests that this set up be used to demonstrate the feasibility of feedback control in manufacturing. Such demonstrations are believed by the Panel to be vital for convincing people in industry, not familiar with these techniques, that automated processing can really work.

IMSE Long-Range Plan

The Panel is pleased with IMSE's response to last year's suggestion. This year's plan is fully acceptable in view of the transition facing NIST. The Panel remains concerned that, in addition to the added responsibilities placed on NIST by law, IMSE maintain its traditional excellence and services in science, data, and standards. The planning task at hand is to define a vision of where IMSE should be in 5 years, not only to perform its former role, but also to provide the industrial support authorized by Congress.

Definition of a program for industrial interaction and support triggered numerous discussions during the Panel meetings. The Panel suggests that IMSE management develop a vision of its future by either forming an industrial advisory board consisting of chief executive officers of major and minor industries affected by IMSE's expertise (This advisory board should to identify major issues facing their industries that could be addressed by IMSE.), or visiting industrial firms of potential economic impact. (Visits should involve the IMSE Director and selected staff and should be arranged at the highest possible level within the firms and address areas of strategic importance rather than risk focusing on short-term problems that would surface in low-level interactions.)

The Panel also suggests that NIST or IMSE join and participate actively in the Industrial Research Institute (IRI). Such interaction could help define issues of industrial interest and thus formulate and maintain a current vision of the future.

IMSE Initiatives

The Panel was pleased with progress to date in Automated Processing of Materials and in the Composite Initiative. Since other significant achievements will be reported in detail in later sections of this report, the Panel now chooses to suggest a few initiatives.

Modern technology finds that the properties of alloys and base metals cannot satisfy the needs of modern industry. Increasingly, industry relies on powder technology and near net-shape fabrication to produce mechanical parts and components. The Panel recommends that IMSE formulate an initiative on near net-shape processing. This initiative should focus in part on the synthesis of the powders. The Panel emphasizes that by synthesis it means the science of homogenous formation of powders of known materials and not necessarily the production of new materials. Special attention should be on characterizing powder surfaces and the influence of surfaces on compaction characteristics.

Also, the Panel recommends the formulation of an initiative on standards and data. Industry is relying more and more heavily on computer modeling to design parts, components, and processes. Efficient codes for linear and nonlinear finite element analysis are readily available nowadays. Models can be generated, but, too often, data are not available to perform the needed analyses. In view of the immensity and importance of reliable data required, the Panel suggests that IMSE establish a clearinghouse for certifying data and laboratory measurements. This initiative should also identify voids in critically evaluated technical databases such as voids in the database for ternary phase diagrams.

IMSE Panel Concerns

The additional mission given NIST by Congress will undoubtedly force changes in the organization and operation of NIST and IMSE. The Panel fears that the effort needed to communicate these changes to the scientific staff might have been underestimated. One of the Panel members, having gone through a similar profound change in his organization, remarked that the effort required to successfully communicate change is always grossly underestimated and that only outside advice enabled his company to inform the staff satisfactorily.

The Panel remains concerned about the apparent gradual shift away from the traditional role of NIST and IMSE as developer and keeper of measurement standards and data. Although this part of the IMSE-NIST mission is losing visibility, it is still vital to the U.S. economy. Without reference standards, not only can commerce not flow in a smooth and efficient fashion, but research on new material systems can be delayed considerably as well. The Panel recommends that the prior initiative be vigorously pursued to counteract this unfortunate shift.

The Panel is concerned that, in view of the new emphasis on industrial involvement, IMSE does not have a clear intellectual property rights position. Patents and rewards to the inventors must become a way of life for those involved in projects directly affecting industry. Licensing cannot be used as a tool to promote industry in the world marketplace unless a world-wide patenting strategy is in place. The Panel recommends that a concerted effort be initiated to develop such a strategy. Perhaps help from some international industrial partners could be sought in this endeavor.

NIST AND IMSE ORGANIZATION CHARTS

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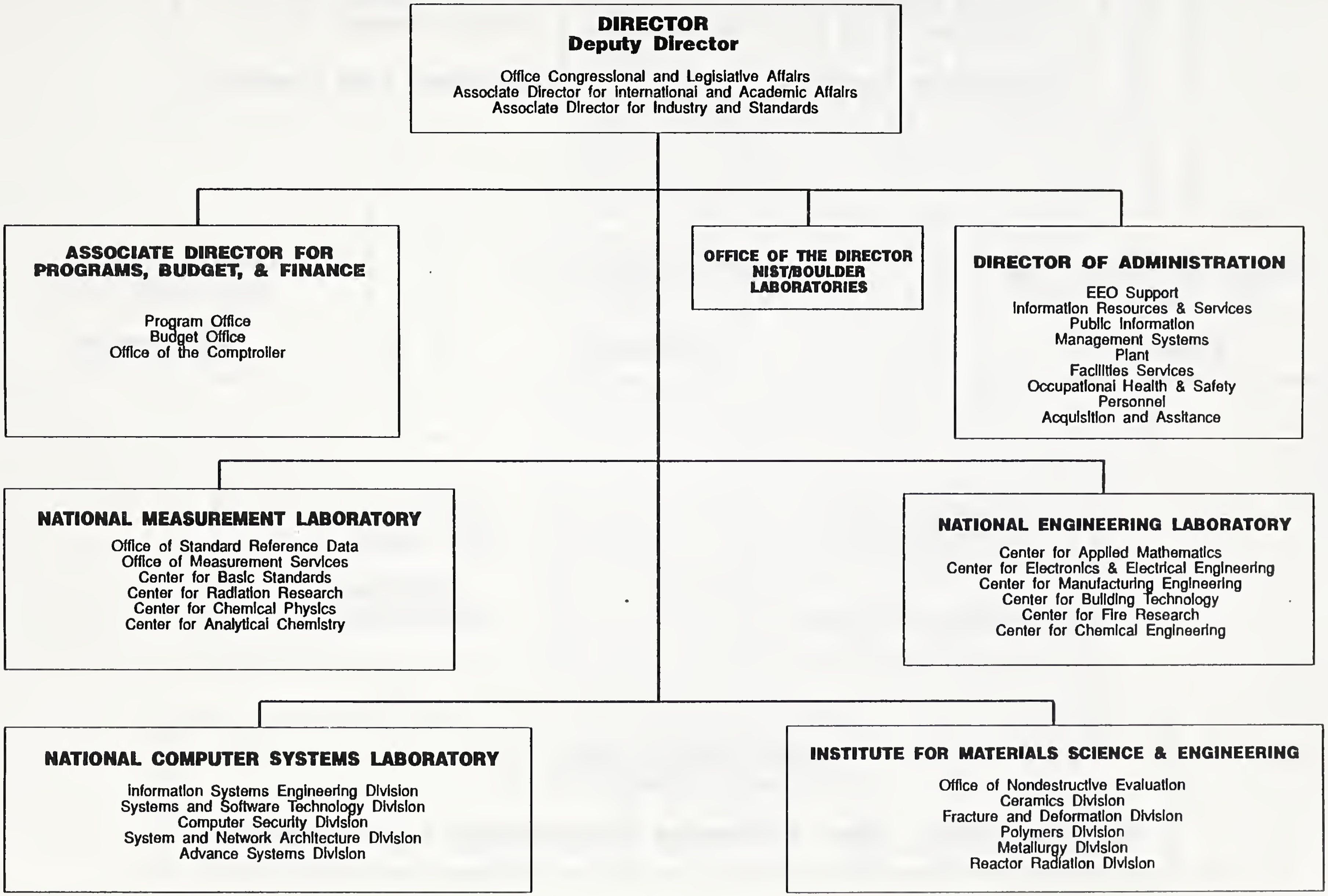

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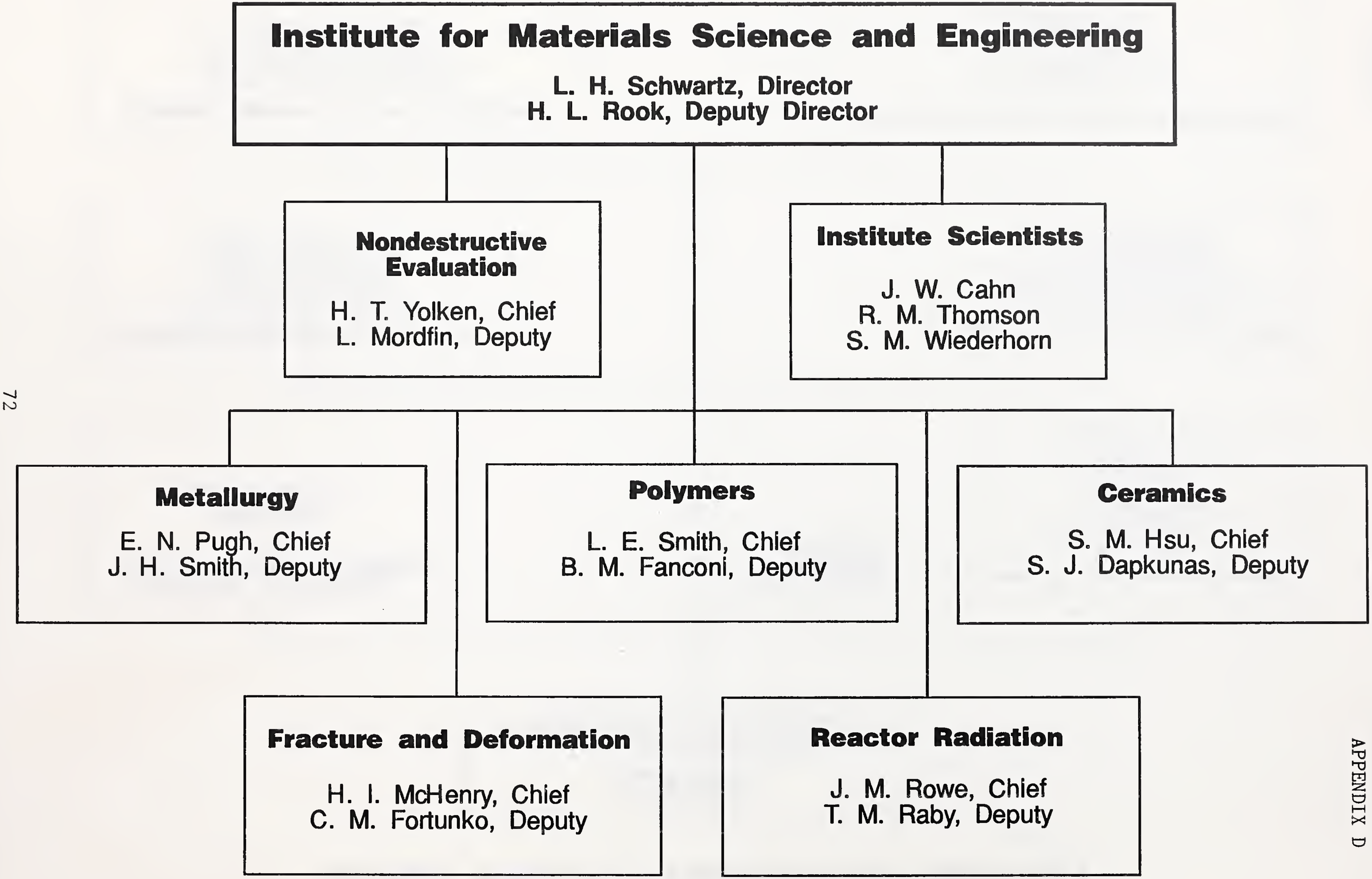
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FUNCTIONAL STATEMENT

MATERIALS SCIENCE AND ENGINEERING LABORATORY

Develops and maintains the scientific competencies and experimental facilities necessary to provide the Nation with a central basis for uniform physical measurements, measurement methodology, and measurement services fundamental to the processing, characterization, properties and performance of materials, and to other essential areas in materials science; provides government, industry, universities, and consumers with standards, measurement methods, data, and quantitative understanding concerning metals, polymers, ceramics, composites, and glasses; characterizes the structure of materials, chemical reactions, and physical properties which lead to the safest, most efficient uses of materials; improves materials technologies, provides the bases for advanced material technologies, in basic and high-technology industries, and encourages recycling; obtains accurate experimental data on behavior and properties of materials under service conditions to assure effective use of raw and manufactured materials; provides technical information such as reference data, materials measurement methods, and standards to processors, designers, and users for selection of cost-effective combinations of materials, processes, designs, and service conditions; uses the unique NIST reactor facilities to develop neutron measurement methodology, develop sophisticated structure characterization techniques, reference data, and standards; participates in collaborative efforts with other NIST organizational units in the interdisciplinary developments in materials science; and disseminates generic technical information from the Divisions to private and public sector scientific organizations through special cooperative institutional arrangements and through conventional distribution mechanisms.

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☐ DOCUMENT DESCRIBES A COMPUTER PROGRAM; SF-185, FIPS SOFTWARE SUMMARY, IS ATTACHED.

11. ABSTRACT (A 200-WORD OR LESS FACTUAL SUMMARY OF MOST SIGNIFICANT INFORMATION. IF DOCUMENT INCLUDES A SIGNIFICANT BIBLIOGRAPHY OR LITERATURE SURVEY, MENTION IT HERE.)

The 1989 Annual Report was prepared for the NAS-NRC Board of Assessment of the Materials science and Engineering Laboratory. This volume contains background information on resources, activities, and representative highlights of the Laboratory.

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